

OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

January 8 - January 14, 1999

Summary 99-02

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EVENTS

1. FLASH FIRE IN WEAPONS CELL DURING CLEANING OPERATIONS

On December 29, 1998, at the Pantex Plant, in a weapons disassembly cell, a production technician was cleaning a weapons case component with a solvent and scraping it with a wooden tongue depressor to remove sealant material when he saw a blue flash and felt heat. The flash caused kimwipes® that were under the component to ignite. This cell also contained a detonator, high explosives, and special nuclear material. Production technicians in the area immediately extinguished the fire with a hand-held fire extinguisher. They then evacuated the cell and notified the appropriate personnel. Fire department personnel and radiation safety personnel responded and confirmed that the fire was extinguished, that no radiological contamination resulted from this event, and that the fire affected no high explosives or special nuclear material inside the cell. The facility manager suspended weapons activities inside the cell and initiated a Type C investigation. The Type C investigation will evaluate the use of flammable chemicals inside the cell and will determine the ignition source. OEAF engineers will follow this event and will provide additional information as it becomes available. (ORPS Report ALO-AO-MHSM-PANTEX-1998-0094)

KEYWORDS: fire, combustible materials, chemical reaction, high explosives, special nuclear material

FUNCTIONAL AREAS: Explosive Safety, Chemistry, Fire Protection

2. WORK PERFORMED WITHOUT RADIOLOGICAL WORK PERMIT

On January 7, 1999, at the Los Alamos National Laboratory, during the critique of an event in which a worker's anticontamination coveralls that had become contaminated were found in a change room, a facility manager learned that the work had been performed without a radiological work permit and without the knowledge of an area work supervisor or facility management. The worker had been wrapping flanges on solution lines with clear plastic. The wrapped lines are external to gloveboxes that are located in a room of the Plutonium Processing and Handling Facility that contains plutonium-242. The worker's coveralls had 6,000 dpm/100 cm² alpha on the lower left leg and 2,000 dpm/100 cm² alpha above the left chest pocket. Working without the requirements and guidance of a radiological work permit or without the knowledge of supervision or management is a violation of Laboratory policy and procedure. (ORPS Report ALO-LA-LANL-TA55-1999-0001)

On January 6, an actinide chemistry room supervisor had asked the worker, an employee of the support services subcontractor, to wrap the flanges on the solution lines. The flanges were not radioactive, but it has been a practice to wrap them with clear plastic so that in the event of a leak, the leak is contained and personnel can see the liquid, making them aware of the problem. The supervisor who assigned the work did not consider that the work, which is a unique operation and not performed regularly, would need a specific radiological work permit. He also did not notify the area work supervisor, who has signature approval authority for the permits, or facility management that the work was being performed. The worker, who had site-specific training, also should have recognized the need for a permit and the need to notify supervision and management.

Facility management originally conducted the critique because the worker's contaminated coveralls were in the men's change room, which is not a controlled radioactive contamination area. A radiological control technician (RCT) had cleared the worker to enter the change room, believing the coveralls were not contaminated, even after the worker caused a stationary contamination monitor to alarm at 8,000 dpm/100 cm² alpha. The RCT, who had responded to an automatic page from the stationary monitor, surveyed the worker with a hand-held monitor and detected no contamination. He had the worker reuse the stationary contamination monitor, which again alarmed at 7,000 dpm/100 cm² alpha. Additional whole-body surveys found no contamination, so the RCT directed the worker to use a second stationary contamination monitor, which did not alarm. He then allowed the worker to proceed to the men's change room. A supervisor and another RCT, responding to the second automatic page, retrieved the worker's coveralls from the change room. They discovered the contamination with a hand-held survey instrument while stretching the material of the coveralls. A Laboratory procedure for responding to stationary contamination monitor alarms requires an RCT to observe two consecutive counts without an alarm on a stationary monitor before deciding that an alarm is false if contamination cannot be detected with a hand-held instrument. In this event the RCT observed only one count without an alarm, which was not in accordance with procedure.

RCTs verified that the worker had no skin contamination or internal exposure. They found no contamination in the change room but detected contamination on a pipe elbow in the room where the worker had wrapped the lines. RCTs removed the contamination.

This event illustrates the need for workers to be accountable and consider the consequences of performing work outside the scope of procedures, radiological work permits, and work packages. A radiological work permit should have been implemented for this task, and the area work supervisor and facility management should have been informed. Personnel working at DOE facilities should have a continually questioning attitude toward safety issues. Each individual is ultimately responsible for complying with rules to ensure personal safety. Facility managers should communicate a sound policy, stressing that safety is of prime importance and that all personnel must exhibit an individual commitment to excellence and professionalism. Managers should ensure that radiological protection practices are followed and enforced.

DOE/EH-0256T, *Radiological Control Manual*, states: "Each person involved in radiological work is expected to demonstrate responsibility and accountability through an informed, disciplined, and cautious attitude toward radiation and radioactivity." The manual sets forth DOE guidance on the proper course of action in the area of radiological control, including work preparation; work controls; monitoring and surveys; and training and qualifications.

- Article 122, "Worker Attitude," states: "Minimizing worker radiation exposure can be achieved only if all persons involved in radiological activities have an understanding of and the proper respect for radiation."
- Article 123, "Worker Responsibilities," states that trained personnel should recognize that their actions directly affect contamination control, personnel radiation exposure, and the overall radiological environment associated with their work. The first rule of worker responsibility is to obey posted, written, and oral radiological control instructions and procedures, including instructions on radiological work permits.

- Article 321, "Radiological Work Permits," and Article 322, "Use of Radiological Work Permits," provide guidance for preparing and using radiological work permits.
- Article 338, "Monitoring for Personnel Contamination," and Appendix 3D, "Guidelines for Personnel Contamination Monitoring with Hand-Held Survey Instruments," provide guidance for conducting whole-body surveys.
- Article 341, "Requirements," states that radiological work activities shall be conducted as specified by the controlling technical work document and radiological work permit.

KEYWORDS: procedure, radiological work permit, survey, violation

FUNCTIONAL AREAS: Radiation Protection

3. ACCIDENTAL DISCHARGE OF COMPRESSED GAS CYLINDER

On December 8, 1998, two firefighters at the Brookhaven National Laboratory were slightly injured when one of them accidentally discharged an 800-psi carbon dioxide (CO₂) cylinder. The discharge propelled the cylinder from a cart that workers had used to transport it to a parking area. The cylinder spun out of control and struck one of the firefighters on the calf, inflicting a deep-muscle bruise. The other firefighter fell as he was trying to avoid the cylinder and experienced a scraped elbow and knee. One firefighter was transported to a local hospital and the other was treated at the site clinic. Both returned to work the same day. The facility manager stood down further work on the cylinders and directed the safety engineering group to conduct an investigation. This occurrence is significant because uncontrolled discharge of high-pressure compressed gas cylinders can cause severe injury or material damage. (ORPS Reports CH-BH-BNL-BNL-1998-0041)

Compressed gas cylinders in CO₂ fire suppression systems are actuated by a variety of pneumatic, electromechanical, or manual methods. However, features common to all cylinders include a discharge head connected to a discharge valve. The discharge head contains an actuating mechanism that acts upon an extension of the discharge valve to open it. The actuating mechanism generally is activated by remote means, such as a fire supervisory signal. The discharge valve is designed to release cylinder contents within seconds. It has a poppet action, that is, gas cylinder pressure slams the discharge valve open when the actuator moves it past a threshold position. Some discharge valves are also equipped with hand levers that may be used to open the valve manually upon failure of automatic actuation. Good engineering practices for removing a CO₂ cylinder from service and transporting it include removing the discharge head, installing a safety cap over the discharge valve, and installing a diffuser cap on the side discharge port. The safety cap protects the discharge valve stem to prevent accidental discharge. The diffuser cap, also called an anti-recoil device, dampens recoil forces by directing exhaust gas in several directions. Although these measures disable automatic actuation, hand levers remain functional.

Investigators for this occurrence determined the following.

- Pipe fitters had removed the cylinders from a fire suppression system that was decommissioned. Firefighters were discharging the cylinders to prepare them for hydrostatic testing before releasing them to be used in other systems.
- After firefighters at Brookhaven National Laboratory had discharged several cylinders without incident, one of them accidentally operated the hand lever for a cylinder, which placed it into the immediate discharge mode.
- The cylinder was secured in a cart in accordance with site procedures for handling and storage of compressed gas cylinders.
- The workers who removed the cylinder from service had not removed the discharge head, nor had they installed a safety cap or a diffuser cap.
- The firefighters had been working without a written procedure or checklist.

OEAF engineers reviewed two other occurrences in the ORPS database involving accidental discharge of compressed gas cylinders.

- At the Savannah River Plutonium Processing and Handling Facility, a cylinder containing 33 pounds of Halon completely discharged as fire protection personnel were removing it from service for scheduled checks. Workers had not yet removed the cylinder from the cylinder brackets, and no personnel were injured. The Halon system contained cylinders and pneumatic actuators supplied by two different manufacturers, Ansul and Halax. On both types, inert gas pressure at 150 percent of cylinder pressure holds the discharge valve closed. As a matter of good shop practice, workers install a safety cap over the discharge valve before they move a cylinder. Workers did not notice that a Schraeder valve used to charge the actuator on one of the cylinders protruded above the face of the actuator. They retrieved a safety cap from another cylinder, but as it turned out, they placed a cap for a Halax actuator over the Schraeder valve for an Ansul actuator. Safety caps for these valves normally are located at or near individual cylinders; however, some of the caps had been misplaced over time. Installation of the improper cap opened the Schraeder valve, released pneumatic pressure from the actuator head, and initiated the Halon discharge. (ORPS Report SR--WSRC-FBLINE-1998-0034)
- At the Oak Ridge Y-12 Site, two plant fire department workers narrowly escaped injury during an uncontrolled release of a CO₂ cylinder. The workers were preparing to discharge several cylinders removed from an obsolete fire suppression system. They were investigating the feasibility of using a hand lever attached to the discharge valve as a means of discharging the cylinders, and one of the workers moved the lever slightly in an attempt to partially open the discharge valve. The operation moved the discharge valve past its threshold position and caused a complete actuation. The discharge propelled the cylinder from a storage building into a paved parking area. After spinning approximately 30 feet, it contacted a concrete ramp that stopped its movement. Investigators cited use of other than knowledge-based procedures as the direct cause of the occurrence. They cited lack of a formal work planning and administration regimen in the plant fire department as the root cause. (ORPS Report ORO--MMES-Y12SITE-1995-0025)

These occurrences underscore the necessity of extreme caution when handling fire suppression system cylinders that have been removed from service. Although safe handling and storage procedures for compressed gas cylinders are well understood, normal storage practices, such as nesting and chaining, are often inadequate to control cylinders with side discharges.

NFPA 12 (1998) and NFPA 12A (1997) contain information and recommendations for designing, installing, and maintaining CO₂ and Halon fire suppression systems. Appendix A, "Explanatory Material," of NFPA 12A contains the following warning.

"Halon system cylinders contain liquefied compressed gas that, if discharged from a cylinder pipe that is not properly connected to system pipe, can propel the cylinder and other equipment with great force. Before disconnecting cylinders from a system, proper safety precautions should be followed. Cylinder outlets should be fitted with anti-recoil devices listed or approved whenever the cylinder outlet is not connected to the system pipe. Safe handling procedures should be followed to transport system cylinders. Actuators should be disabled or removed before the cylinder is released from its bracketing. Proper equipment should be used to transport cylinders, dollies, or carts, and means to secure the cylinder should be used if cylinders need to be transported within a facility.

"Also consult equipment manufacturer representative for specific recommendations."

Although NFPA 12 does not specifically repeat the text of this warning, the warning applies in full to CO₂ cylinders that have been removed from service. In addition, Appendix A of NFPA 12 does state that a cylinder outlet should be fitted with a safety cover or anti-recoil device whenever the cylinder is not connected to the system piping.

Facility operators should consider the following measures to ensure the highest degree of safety in handling fire suppression system compressed gas cylinders.

- Ensure that cylinder actuators are positively disabled before cylinders are removed from service.
- Install approved safety caps and anti-recoil devices immediately after removing discharge pipes or hoses.
- Conduct handling and testing of cylinders in accordance with written procedures that incorporate manufacturer recommendations and precautions.
- Incorporate site or facility work planning and control processes into fire department activities.

DOE/EH-0527, Safety Notice 96-03, *Compressed Gas Cylinder Safety*, contains summaries, corrective actions, lessons learned, and recommendations related to compressed gas cylinder events and contains additional references. Safety Notices are available at http://tis.eh.doe.gov/web/oeaf/lessons_learned/ons/ons.html.

KEYWORDS: compressed gas, carbon dioxide, Halon, fire suppression

FUNCTIONAL AREAS: Fire Protection, Industrial Safety, Work Planning

FINAL REPORT

This section of the OEWS discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. INOPERABLE FIRE SPRINKLERS

On June 12, 1998, at the Argonne National Laboratory–East, fire protection engineers determined that 11 of 12 sprinkler heads failed to operate when tested. They were testing the sprinklers because of problems identified in Occurrence Report CH-AA-ANLE-ANLEPFS-1998-0004. None of the sprinklers were internally obstructed with foreign material, though all exhibited signs of external corrosion. The sprinkler heads failed to operate because of an inadequate O-ring seal. This resulted in a buildup of corrosion products on the exterior of the sprinkler that would render the valves inoperable during a fire or related event. Unsatisfactory performance of automatic fire sprinklers can result in excessive fire damage or injuries to personnel. (ORPS Report CH-AA-ANLE-ANLEESH-1998-0001)

All of the failed sprinkler heads were Reliable Model “A” flush pendant sprinklers. Of approximately three dozen sprinklers tested, all but one failed to operate at 7 psig, the minimum design pressure used in sprinkler hydraulic calculations. Two sprinklers tested by Underwriter’s Laboratories, Inc., failed to open at 100 psig. One sprinkler tested by Factory Mutual opened at 350 psig. Typical pressures supplied to these heads range from 20 to 40 psig. Several on-site analytical groups and outside consultants analyzed the corroded sprinkler heads and determined that the increase in the pressure necessary for them to operate was probably the result of improperly cured silicone rubber O-rings. Microscopic cracks in an O-ring allow water to seep past the seal. As this water evaporates, corrosion products are deposited, effectively cementing the sprinkler components together. The facility manager ordered the replacement of 2,870 Reliable Model “A” flush pendant sprinklers. The sprinkler replacement effort included system flushing and piping upgrades to correct known hydraulic deficiencies. The facility manager sent a letter to Reliable Automatic Sprinkler Company enlisting its assistance in resolving this problem and will retain replaced Model “A” sprinklers pending the outcome of negotiations with Reliable.

Occurrence report developers identified the following lessons learned.

- General safety inspections provide valuable opportunities to identify problems that may be overlooked in the course of more formalized testing and maintenance activities.
- Sprinkler O-rings may be subject to a variety of failure modes, not all of which have been recognized by the fire protection industry. Sprinklers that use O-rings should be regularly sampled and tested. New installation of sprinklers that use O-rings is not recommended.
- Sprinklers in which operating components are concealed from visual inspection may be impaired in ways that are not readily apparent. Their use for new sprinkler installations is not recommended.
- Sprinkler sampling as required by NFPA 13 may not be adequate to ensure system operability in all cases. Additional sampling may be conducted without program interruption and at essentially no cost by routinely examining sprinklers when a facility is renovated. Because such examinations will occur most frequently in buildings that are the most active, this is an automatically graded approach.

NFS reported other problems with malfunctioning sprinklers in Weekly Summaries 98-41, 98-12, and 97-49. These problems involved Omega fire sprinklers manufactured by Central Sprinkler company. The Omegas also feature O-rings in their design. They were recalled by the manufacturer as required by the Consumer Products Safety Commission (CPSC). Additional information on the CPSC recall of Omega sprinklers can be obtained at <http://www.cpsc.gov/cspcpub/prerel/prhtml99/99008.html>.

DOE Safety Alert DOE/EH-0518, January 1999, "Potentially Defective Automatic Fire Sprinklers," addresses recent DOE sprinkler problems. This Safety Alert is available at http://tis.eh.doe.gov/docs/hha/hha_99_1.html. The Safety Alert recommends the following actions.

- Survey all facilities protected by automatic sprinklers for Omega and Reliable Model "A" sprinklers.
- Replace Omega sprinklers in accordance with CPSC recommendations. Remove samples of Reliable Model "A" sprinklers and test for operability. Use the results of these tests to guide decisions on replacement.
- Pending replacement of sprinklers that are determined to be potentially defective, establish interim compensatory measures.

- Share results of surveys and tests with appropriate DOE and fire safety officials. The results of these activities should also be shared with the DOE fire safety community via the fire protection listserver, which is accessible from the DOE Fire Protection home page, located at <http://tis.eh.doe.gov/fire/>.

KEYWORDS: corrosion, fire suppression, inspection, sprinkler

FUNCTIONAL AREAS: Fire Protection, Industrial Safety

2. POWER FEED FAILURE

On November 13, 1997, at the Brookhaven National Synchrotron Light Source Facility, fire and rescue personnel responding to a building alarm discovered that a dry pipe sprinkler system had charged with water, but no sprinkler heads had activated. They also discovered charred exteriors on an electrical pull box and conduit pipes in the building, soot on the floor and on components near the pull box, and an odor of smoke. Electricians locked out and tagged electrical circuits associated with the pull box and removed the pull box cover. They discovered heavy deposits of soot on the walls and on cables inside the pull box. This occurrence forced the shutdown of a research facility approximately 2 days before a scheduled shutdown and resulted in substantial financial impact because of lost research time and recovery costs. (ORPS Report CH-BH-BNL-NSLS-1997-0005)

The facility manager appointed a committee to determine the nature of the occurrence, its causes, and appropriate corrective actions. Committee members determined the following.

- During simultaneous fires in plastic underground conduits that connect the pull box with two substations, 15 of 24 480-V, 1,600-amp cables experienced severe damage. A fire in one conduit apparently spread to other conduits. The fires, which burned insulation and melted copper conductor, self-extinguished when electricians removed power from the cables.
- Investigators discovered evidence of the intrusion of water, sand, and gravel into the conduits during visual inspections with a borescope. They also discovered evidence of moisture-induced copper corrosion in cables removed from the conduits. They believe that failure of the cable insulation may have been caused by microcracks that admitted water. Investigators identified microcracks in cable segments far from the area of the fire.
- The presence of large amounts of sand in the conduits indicated that they are not encased in concrete, as called for by original installation plans.
- Resistance-to-ground tests performed on similar cables installed at about the same time and under the same conditions as the damaged cables yielded values of 2 to 1,300 megohms. Results below 100 megohms indicate insulation deterioration and require further testing and monitoring.
- A breaker feeding one of the damaged cables failed to trip during testing. Examination of the breaker revealed that reliability of the mechanical trip device had been compromised by a failure to carry out recommended maintenance.

- The fire occurred directly below two floor drains into which caustic material is routinely poured. Although substantial deposits of sludge prevented a thorough evaluation of associated piping for possible leaks, investigators identified this proximity as a potential contributor to the degradation of the cable insulation.

Members of the investigating committee concluded that equipment or material problem was the direct cause of this occurrence. A fire, probably caused by a cable fault, spread to cables in adjacent conduits. They identified a less-than-adequate preventive maintenance program as the root cause of the occurrence. The lack of a standard preventive maintenance schedule for 480-V breakers allowed a breaker malfunction to remain undetected. If the failed breaker had operated properly, the damage sustained by the conduits would have been limited. Also, the facility would have experienced only a minor outage with insignificant financial impact. Contributing causes identified by committee members included a lack of resources assigned to preventive maintenance, a lack of scheduled downtime to perform preventive maintenance, and improper installation techniques for the cable ductwork.

The facility manager described the following lessons to be learned from this occurrence.

- Conduct preventive maintenance and inspections for substation breakers, switches, transformers, and other equipment on a regular basis in accordance with industry standards.
- Encase future underground conduits in concrete; separate individual conduits with concrete to prevent damage to adjacent conduits if one conduit fails catastrophically.
- Regularly test high-power underground conduits to monitor for degradation of insulation resistance or dielectric losses.
- Provide enough separation between conduit banks and floor and other drains to preclude leaks from degrading conductor insulation.

KEYWORDS: breaker, conduit, fire, insulation, preventive maintenance

FUNCTIONAL AREAS: Electrical Maintenance, Surveillance

OEAF FOLLOW-UP ACTIVITIES

1. NFS PUBLISHES FOURTH ANNUAL CUSTOMER SURVEY RESULTS

In the continuing effort to maintain and develop the utility, relevance, and overall quality of the Operating Experience Weekly Summary (OEWS), readers were asked to complete a survey. Their responses to the fourth annual survey are summarized as follows.

- The utility, relevance, and overall quality of the OEWS are judged by the respondents to be consistently high.
- Ninety one percent of the respondents think that the OEWS has helped to improve safety performance at their site.

- Six of every ten respondents report that their primary use of the OEWS is in lessons learned programs.
- Slightly more than one-quarter (28 percent) of the readership of the OEWS appear to be managers, while another 26 percent are nonmanagerial engineer/analysts.
- The conclusions are generally in line with those of previous surveys, which showed that respondents were satisfied that the OEWS is high quality, useful, and relevant.

The extensive reach of the OEWS, combined with its frequency, makes it an excellent tool for enhancing the safety culture within the DOE complex, improving the quality of facility operations, and improving lateral integration throughout DOE. The complete results of the fourth annual survey can be viewed on the OEWS website.

2. OEAF PUBLISHES NEW LESSONS LEARNED REPORTS

In December 1998 the Office of Operating Experience, Analysis, and Feedback published two new documents as Lessons Learned Reports. Issue 98-01 is a Lessons Learned Report on Inadvertent Fire Suppression System Actuation/CO₂ Discharge and Issue 98-02 is a Lessons Learned Report on Penetrating Hidden Utilities. This new style of document is intended to provide clear and concise lessons learned, recommendations, and other pertinent information about safety-related activities or events of interest to managers, supervisors, and workers across the complex. The reports are 2 to 4 pages in length and can be carried on clipboards or in workers' pockets for reference during pre-job planning and briefings.